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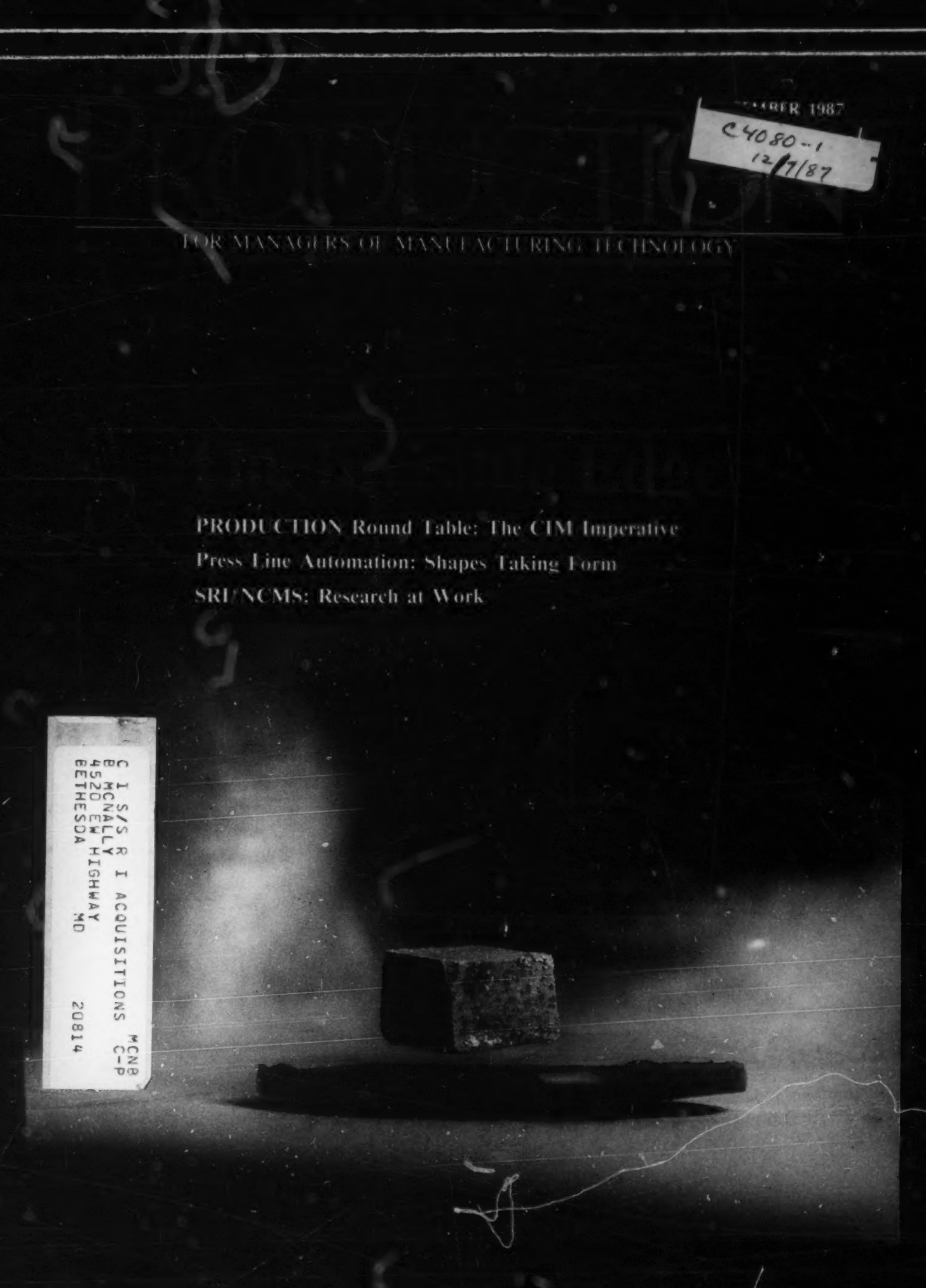

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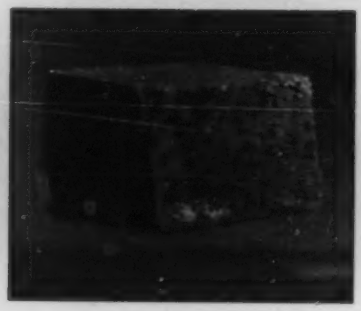

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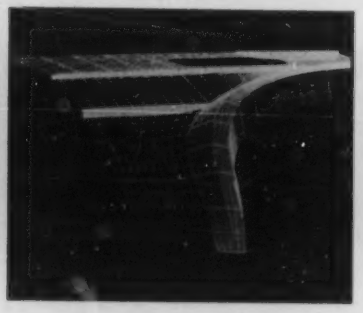

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# Now Hear This!

***Voice technology is making its return to the factory floor. You should hear how well it's doing.***

***By Al M. Senia***
*Regional Editor*

REMEMBER VOICE TECHNOLOGY? WELL, it's back, and thanks to significant technology improvements, it's having a major impact in the manufacturing environment. With increasing frequency, computers are responding to human voice on the factory floor, allowing workers to capitalize upon computer assistance while maintaining the ability to concentrate on the task at hand. Increasing productivity and improving accuracy are the results.

So far, the largest use of voice technology in the factory setting has been for order entry, inventory and quality control—simple operations where an employee can use his voice instead of a notepad to keep track or inspect parts or other stock. But the industry is set to boom, and a variety of advanced applications are on the horizon, especially in the aerospace field.

At some more recent installations, voice has supplemented or replaced bar code or keyboard entry, increasing efficiency by three- or four-fold. Even more dramatic productivity gains are promised for the future, when voice is expected to encompass such areas as machine control, information management and the various components of computer-integrated manufacturing.

Voice can be used for such tasks as sorting parts and packages, activating CAD/CAM systems, controlling robotic arms and, of course, entering the serial numbers of parts.

**The economic outlooks.** Already officials and industry analysts estimate more than 10,000 voice-data systems are in place. Most are being used in the parts control and quality assurance areas. But the market is growing and expanding.

Some industry analysts foresee a $1.5 billion annual market by the middle of the next decade, although it has thus far remained difficult to characterize and very undefined.

"It's not perceived as a large market yet," says one analyst with Future Computing Inc., a Texas-based research firm. "I'm real wary of characterizing it, since it is unclear to me that it is exactly a market at this time. We're talking technology rather than market."

Shelly Bakst, an analyst with International Data Corp., a Framingham, MA research firm, pegs the current U.S. voice recognition market at $28.3 million, growing to $68.3 million by 1989. What's fueling the rise in demand?

A variety of factors. Initial factory installation at such companies as Caterpillar Inc., Inland Steel, General Motors, Honeywell, Westinghouse, and others are proving successful, demonstrating the viability of the technology. The military is pouring millions of dollars in research and development efforts into futuristic weapons systems using voice.

Even more significantly, after leaving voice technology to relatively small pioneering developers such as Votan (Fremont, CA), Dragon Systems Inc. (Newton, MA), and Kurzweil Applied Intelligence (Waltham, MA), large manufacturers like AT&T, IBM, Intel Corp., Texas Instruments, and NEC Corp. have begun marketing their own voice systems. This has added more credibility to the technology, prodded greater R&D and introduced an element of price competition.

"A wave of applications is emerging from companies that began R&D efforts using TI-Speech™ products a year or more," explains Doug Palmer, speech marketing manager, Texas Instruments' Data Systems Group. "And with the upsurge in speech business that TI has experienced, we expect a further proliferation of applications in the future since development efforts typically take at least a year."

**Inauspicious beginnings.** Despite the excitement surrounding voice in

*Improved quality assurance at Austin-Rover is being attributed to the use of a Votan voice technology system used by inspectors.*

the manufacturing setting, the technology has taken a good deal of time to prove its worth. And it has found even wider use outside the manufacturing market in such industries as health care, the telephone industry and various consumer products.

In its simplest phase, voice synthesis, speech sounds are stored into memory chips and converted into audio signals that mimic human speech. The regional telephone companies, for example, have made wide use of this technology in their directory assistance services.

Speech synthesis first appeared as a consumer product in the automotive industry, when Japanese manufacturers briefly introduced cars with computer chips that would bark commands to drivers like "Buckle your seatbelt!" and "The front door is ajar!" But consumers became annoyed at the gimmick and the manufacturers retreated, putting the technology back on the shelf.

However, as the voice recognition segment of the industry has grown—the technology where the computer recognizes human speech and responds in a synthetic "speech-like" voice, often combining elements of artificial intelligence—new, dramatic applications came into prominence.

**Voice in car production.** Voice technology eventually returned to the automotive industry.

The London-based Austin-Rover Group is using an IBM personal computer-based Votan voice system in its quality assurance operation for 5,000 vehicles daily. Company inspectors directly input defect information via headsets into a computer, instead of relying on clipboards and then keystroking the data.

Final car inspection time has been cut in half, has reduced errors by an estimated 80 percent and allows for the instantaneous communication of quality assurance data to manufacturing areas where any mistakes are rectified.

Company officials said the system is also useful in compiling statistical trends and spotting consistent manufacturing problems, since quality information from every station is placed into a computerized databank from which managers can draw.

"The primary reason the system has been so successful at Austin-Rover is its almost universal acceptance by operators," comments Rob Anderson of the company's manu-

facturing systems division. "Once an operator has learned to produce a voice print that the system can recognize as his and begins to learn the words the system understands, training can be completed in about half an hour."

Anderson notes that most operators require approximately five days to become comfortable with the system.

Volkswagen of America is utilizing a voice-activated computer system on its final assembly line in New Stanton, PA. It may be expanded to quality control operations in the body and paint shops.

It uses a Westinghouse system that allows quality control checkers to stray 200 ft from a vehicle, transmitting data to a voice-activated computer via headset. Nearly 100 different items are checked daily; the system can recognize the voices of four employees.

The voice system cost Volkswagen approximately $100,000. Officials say it has already paid for itself through productivity improvements.

The "Big Three" American automakers have been less successful with voice technology, although they have experimented with it since 1975. One official with Intel, which has been marketing turnkey voice systems to the automotive industry, said both Ford Motor Corp. and General Motors Corp. are poised to utilize the technology in parts inspection and final inspection tasks.

Intel already has installed an interactive voice system at a plant of Caterpillar Inc. in Davenport, IA. The system is used for quality control and inspection tasks, receiving and warehouse operations, data collection on the factory floor and inventory control.

**Other quality assurance tasks.** Voice systems also are being widely utilized for routine quality assurance tasks in the aerospace and electronics industries. At Rockwell International in Cedar Rapids, IA, a voice entry system increased the accuracy and efficiency of circuit board inspection between 30 and 40 percent.

***Will voice technology take off? Some companies are optimistic that it will, particularly since it is so widely applicable.***

Inspectors took two weeks to learn the system; officials say it has a recognition accuracy level of 95 percent. The system recognizes 40 to 50 words and phrases that indicate the location and the type of defect.

"The system is working fine," says Rockwell's Chuck Johnson. "It is different than anything else in the plant."

Vought Aero Products Group in Dallas also is using a Votan-designed voice system at the receiving dock, where workers verbally input into a host computer via wireless microphone, the materials that are arriving. The computer verifies and either accepts or rejects each shipment.

"We've tested the system at excessive noise levels...from forklifts, conveyor belts and yelling workers without any problems," says Doyle Landers, quality assurance systems analyst.

The Douglas Aircraft Division of McDonnell Douglas Corp. also is making successful use of voice technology as part of an ongoing quality assurance program at its Torrance, CA facility.

The system, developed a year ago by company employees, is used to write more accurate failure and rejection reports on machined parts. It has eliminated many problems—such as poor spelling and grammar, invalid entries and indecipherable handwriting—that slowed the processing of rejection reports.

The system also prompts inspectors to provide all the information that engineers need to know, reducing return of the forms to the department.

It has been working successfully in a very noisy factory environment. Officials hope to expand the system throughout the plant by 1992.

Voice technology also has had an impact in quality assurance and inspection in more traditional heavy industry. Inland Steel Corp. installed a Votan VTR 6050 voice system to process steel more accurately.

Officials say their productivity has increased and their costs reduced by using voice data entry for the large slabs of steel that enter the mill and are processed through 15 different stations.

The data determines if the steel should be rolled into plates and heat-treated, flame cut or reprocessed. The voice system makes the information from each station available immediately, keeping the lines moving more efficiently and increasing accuracy as orders are processed.

"Each load used to be a hit-or-miss situation," explains one quality control official. "The system makes our jobs a lot easier and decreases the number of rejected loads." P

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JANUARY 1988

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FOR MANAGERS OF MANUFACTURING TECHNOLOGY

# 1988 Capital Spending Survey

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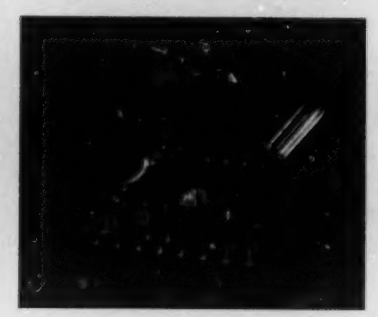

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# Capital Spending: The Ascent Begins

***PRODUCTION finds a 7.7% increase in spending in 1988. Which is good, considering the doldrums of the past few years. The number-one reason: cost-reduction programs.***

*By Edward D. McCallum, Jr.**
*Market Research Consultant*

**Mr. McCallum, a vice president of Indumar, Inc. (Cincinnati, OH), a marketing research/consulting firm, has conducted the PRODUCTION survey for the past 20 years.*

## *Comparison of Spending Intentions, 1987 and 1988*

| Machine/Equipment Type | Percent Total Investment 1988 | 1987 | Total Projection (Million $) 1988 | 1987 | Percent Change 1988/1987 |
|---|---|---|---|---|---|
| Metalcutting | 35.9 | 38.4 | 3,160 | 3,128 | + 1.0 |
| Domestic Sourced | 48.0 | 48.8 | 1,520 | 1,528 | − 0.5 |
| Offshore Sourced | 52.0 | 51.2 | 1,640 | 1,600 | + 2.5 |
| Metalcutting | 15.1 | 12.3 | 1,330 | 1,003 | +32.6 |
| Domestic Sourced | 58.0 | 57.5 | 771 | 577 | +33.6 |
| Offshore Sourced | 42.0 | 42.5 | 559 | 426 | +31.2 |
| Assembly | 11.7 | 14.5 | 1,030 | 1,181 | −12.8 |
| Other | 8.9 | 5.4 | 782 | 440 | +77.7 |
| Gaging/Inspection/ Testing | 7.9 | 8.5 | 694 | 692 | — |
| Cleaning/Finishing | 6.8 | 6.8 | 598 | 554 | + 7.9 |
| Material Handling | 5.1 | 5.1 | 448 | 415 | + 8.0 |
| Welding/Riveting/ Brazing | 4.1 | 3.9 | 360 | 318 | +13.2 |
| Plastic Molding | 2.5 | 2.9 | 220 | 236 | − 6.8 |
| Heat Processing | 1.9 | 2.0 | 167 | 163 | + 2.5 |

*Source: PRODUCTION'S Capital Spending Forecasts 1988/1987.*

## *Spending Profile Based on Plant Size*

| No. of Employees | Machinery/Equipment Expenditures (Before Adjustment) Median | Average Respondent |
|---|---|---|
| Less than 20 | $ 50,000 | $218,680 |
| 20-49 | 75,000 | 233,515 |
| 50-99 | 150,000 | 301,215 |
| 100-249 | 250,000 | 623,956 |
| 250-499 | 550,000 | 907,243 |
| 500-999 | 750,000 | 467,962 |
| 1,000-2,499 | 1,000,000 | 970,400 |
| 2,500 and over | 1,000,000 | 910,806 |

***Observation:** There is an obvious change in investment intentions reported by respondents for 1988. There is more money reported to be spent in plants employing less than 500 persons while less is reported in plants employing 500 or more. This may reflect current and anticipated capacity need change in the smaller, contract supplier as outsourcing trends accelerate. Concurrently large plants (500 or more employees) anticipate spending more on cleaning/finishing, assembly, gaging/inspection/testing and material handling equipment and less on metalcutting and metalforming machines.*

THERE IS GOOD NEWS. METALWORKing industries* will spend about $8.79 billion this year for production machinery and equipment. This projection follows returns to our 20th annual survey of the spending intentions of plants reached by PRODUCTION Magazine. Much of this improvement is based on the fact that 41.0% of the respondents indicate they expect to increase spending above 1987 levels. Last year, 35.4% said they expected to increase capital spending.

**What about Wall Street?** This could be the bad news. The gyrations on the stock market commenced *after* we had gathered data and made projections. So we've been asked what the chances are for the forecast to come true. We don't know. But we do know that high levels of employment and personal income have driven the economy—not perceived wealth. We suspect the lids on operating budgets to be clamped shut for the next few quarters, but since capital needs are *considered* needs, we do not foresee a scaling back at this time.

**Survey highlights.** Major points registered in the survey show:

- Cost reduction continues to be the main reason for machinery and equipment expenditures; it is ranked most important by 40.5% of all respondents.
- The average minimum first year return-on-investment (pre-tax) in justifying new production equipment is 29.0%—the lowest requirement in 10 years. This reflects a slightly larger response from plants employing less than 100 persons where machin-

**Considered for the purpose of this survey to be plants reached by PRODUCTION Magazine in Furniture (SIC 25); Fabricated Metal Products (SIC 34); Machinery, except Electrical (SIC 35); Electrical Machinery (SIC 36); Transportation Equipment (SIC 37); and Instruments (SIC 38).*

*1988 figures are projected from 3,219 respondents from 10,000 plants contacted in the survey last August-September, in keeping with past procedures.*

## *Robots: Current and Future Use*

| | Percent Total Plants Responding |
|---|---|
| Currently use robots | 19.2 |
| Plans for 1988-90 include robot purchases | 22.7 |

**Types of Operations For Which Robots Will Be Purchased**

| Type Operation | Percent of Plants Planning Purchase |
|---|---|
| Arc Welding | 22.6 |
| Spot Welding | 9.7 |
| Assembly | 42.9 |
| Machine Load/Unload | 65.5 |
| Material Handling | 29.9 |
| Spray Painting | 13.9 |

*Note: Purchase trend is down over last two years:*
*1987—29.4% planned purchase*
*1988—34.5% planned purchase*

*Base: Respondents planning robot purchases 1988-90.*

## *To Last Year's Survey Respondents...*

Thank you. Your willingness to share your plant's spending intentions helped us to make projections for 1987 which look like they will be within 5% of what happened. You continue to be good forecasters!

## *And, to This Year's Survey Respondents...*

Your response was the highest in 20 years of surveys. Three-thousand, two-hundred and nineteen of you (out of 10,000) completed and returned their questionnaires. Since we feel there is safety in numbers, we feel confident about the projections you helped us make for 1988.

Thank you very much!

## *Offshore Purchasing*

| SIC | Industry | Percent of Total Respondents Planning Offshore Purchases | Percent of Appropriation Going Offshore* |
|---|---|---|---|
| 3421 | Cutlery | 63.6 | 46.4 |
| 3423 | Hand and edge tools, except Machine tools and hand saws | 43.5 | 43.5 |
| 3429 | Hardware, not elsewhere classified | 46.9 | 51.3 |
| 3433 | Heating equipment except Electric and warm air furnaces | 50.0 | 57.1 |
| 3442 | Metal doors, sash, frames, molding and trim | 57.1 | 49.4 |
| 3451 | Screw machine products | 56.7 | 44.3 |
| 3452 | Bolts, nuts, screws, rivets and washers | 50.0 | 50.3 |
| 3462 | Iron and steel forgings | 64.0 | 49.1 |
| 3469 | Metal stampings, not elsewhere classified | 41.7 | 49.4 |
| 3471 | Electroplating, polishing, anodizing and coloring | 57.9 | 44.5 |
| 3479 | Coding, engraving and allied services, not elsewhere classified | 69.2 | 38.8 |
| 3489 | Ordnance and accessories, not elsewhere classified | 55.5 | 51.0 |
| 3494 | Valves and pipe fittings, except plumbers' brass goods | 57.8 | 42.7 |
| 3499 | Fabricated metal products, not elsewhere classified | 47.1 | 41.3 |
| 3519 | Internal combustion engines, not elsewhere classified | 78.6 | 46.4 |
| 3523 | Farm machinery and equipment | 47.4 | 51.1 |
| 3533 | Oil field machinery and equipment | 66.7 | 34.6 |
| 3541 | Machine tools, metal cutting types | 51.5 | 49.7 |
| 3544 | Special dies and tools, die sets, jigs and fixtures, and industrial molds | 41.5 | 43.2 |
| 3545 | Machine tool accessories and measuring devices | 46.6 | 50.0 |
| 3549 | Metalworking machinery, not elsewhere classified | 60.0 | 50.6 |
| 3551 | Food product machinery | 47.4 | 42.2 |
| 3561 | Pumps and pumping equipment | 56.7 | 54.8 |
| 3566 | Speed changers, industrial high speed drives and gears | 55.5 | 44.0 |
| 3569 | Mechanical powered transmission equipment, not elsewhere classified | 45.0 | 63.9 |

** Those plants planning offshore purchases.*

*(Continued on page 40)*

## *Offshore Purchasing*

*(Continued from page 39)*

| SIC | Industry | Percent of Total Respondents Planning Offshore Purchases | Percent of Appropriation Going Offshore* |
|---|---|---|---|
| 3573 | Electronic computing equipment | 68.4 | 41.1 |
| 3585 | Air conditioning and warm air heating equipment | 50.0 | 37.2 |
| 3599 | Machinery, except electrical, not elsewhere classified | 45.7 | 47.6 |
| 3651 | Radio and television receiving sets, except communication type | 57.1 | 53.7 |
| 3662 | Radio and television transmitting, signaling, and detection equipment and apparatus | 62.9 | 65.0 |
| 3674 | Semiconductors and related devices | 51.8 | 43.6 |
| 3679 | Electronic components, not elsewhere classified | 51.1 | 43.7 |
| 3711 | Motor vehicles and passenger car bodies | 42.3 | 37.7 |
| 3714 | Motor vehicle parts and accessories | 40.2 | 33.5 |
| 3721 | Aircraft | 57.9 | 33.6 |
| 3724 | Aircraft engines and engine parts | 56.3 | 54.4 |
| 3728 | Aircraft parts and auxiliary equipment, not elsewhere classified | 56.5 | 38.7 |
| 3731 | Ship building and repairing | 81.8 | 42.2 |
| 382 | Measuring and controlling instruments | 52.0 | 42.7 |
| 384 | Medical, dental and surgical instruments | 53.7 | 42.8 |
| 386 | Photographic equipment and supplies | 55.6 | 53.2 |

* *Those plants planning offshore purchases.*

ery/equipment often is purchased without ROI criteria.

• 26.0% of the responding plants, up four percentage points from last year's survey, cite an increase in capacity as their primary spending objective. Most of this activity originates in plants with less than 500 employees that expect to be the beneficiaries of outsourcing policies.

• Operating capacity is reported at 76.7%, up from 75% last year. Expectations are up for 1988, with 59.0% planning to operate at a higher level than 1987, 31.7% at the same level, with only about 5% planning to operate at a lower level. Reasons given: 46.0% report incoming orders on the increase, another 21.2% say incoming orders are steady.

• Of the total dollar projection for 1988 capital expenditures, 69% will be placed with domestic sources with the remaining 31% with offshore sources. That portion of equipment budgets supplied by the domestic equipment builders has stabilized after declining for the last five years. The dollar's decline against other trading partner currencies is the probable reason.

• After a slow start compared to other industries, the use of computers for manufacturing operations in discrete parts industries is taking off. 73.4% of the total respondents report use of computers in manufacturing operations and 52.3% report plans for 1988-90 include purchase, or lease, of computers and software for manufacturing purposes.

• 37% of the respondents report having an approved capital budget at the time of the survey; about half of the remaining 63% expect approvals by year end with the remainder in the first quarter of 1988. Those awaiting budget approval expect to obtain 91%, on average, of what they asked for.

**How the money will be spent.** As has been the case in each of the 20 surveys conducted, metalcutting machine tools will capture the largest share, 35.9%, of the 1988 capital equipment dollar. That amounts to $3.16 billion and will approximate 1987 order activity.

Metalforming equipment accounts for the second largest item in the investment budget at 15.1%, or $1.33 billion, and continues to show growth as it has for the last two years. Assembly machinery/equipment at 11.7%—$1.03 billion—is next. Gaging/inspection/testing will account for 7.9%; cleaning/finishing equipment, 6.8%; materials handling, 5.1%; welding/riveting/brazing, 4.1%; plastic molding, 2.5%; heat processing, 1.9%. The catchall "other" will take 8.9% of the capital budget and will be up about 75 percent over the 1987 projections.

**Technology-intensive Equipment: Steady and Slow**

**NC/CNC equipment.** 62.5% of all respondents report their plant currently operates NC/CNC equipment. Inasmuch as this only represents an

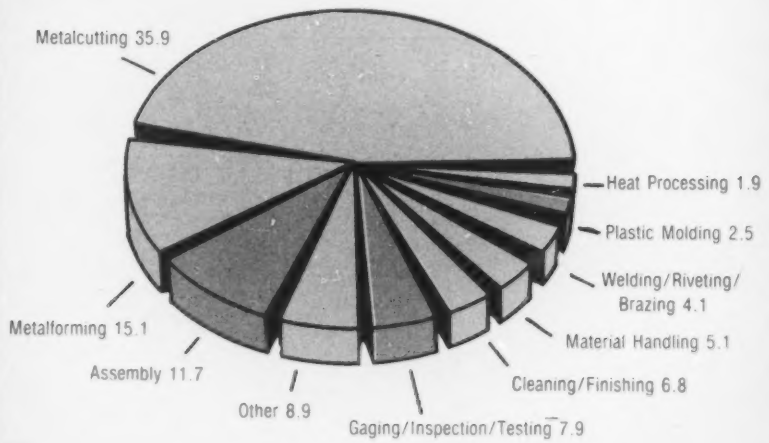
increase of 32% in installations since 1978, it appears that something less than 70% of all plants represents the total user market for CNC equipment. As in past years, horizontal and vertical machining centers and horizontal turning machines account for the largest share of the 46.1% of the plants that plan CNC purchases over the next three years. Grinding, milling and punching will account for most of the remainder.

**Flexible manufacturing.** Cells and systems continue to be considered options for lowering producer costs. 14.9% of all respondents report their plants currently operate cells; 14.4% indicate they plan to purchase cells over the next three years. (A cell was defined as comprising one materials handling device servicing multiple machines which are coordinated and placed by a computer or programmable controller.) Current and planned use of cells approximate last year's use and planned purchase.

10.5% of the total respondents report they currently operate flexible manufacturing systems (FMSs) for machining, forming or assembly purposes. 11.2% report plans to purchase FMSs in 1988-90. Most of the interest in FMSs stems from plants employing over 250 employees. (For the purpose of definition, a flexible manufacturing system [FMS] is comprised of multiple material handling devices servicing multiple machines with a computer responsible for coordinating, pacing and scheduling.)

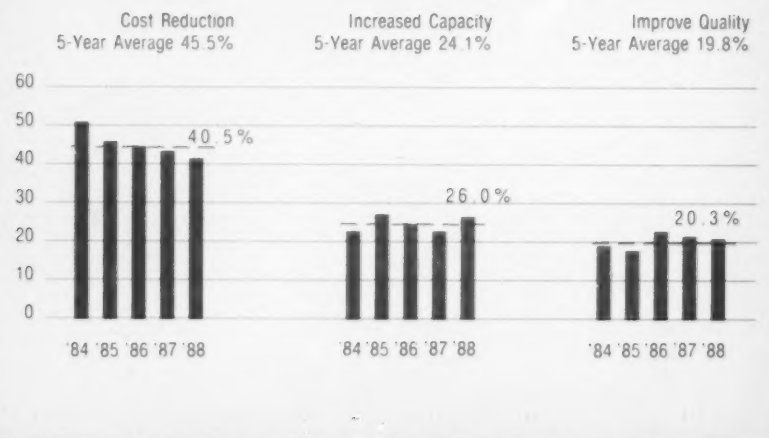
**Electrical discharge machines (EDMs).** 9.4% of the total respondents plan purchase of EDM equipment over the next three years, down slightly from last year and the year previous. Over 65% of their purchases will originate outside the traditional independent tool and die and mold market (SIC 3544). Better than half of these planned purchases will be accounted for by first-time users. Wire EDM continues to account for the majority of sales with a ratio of 1.5:1.0 over ram (standard) EDM. 20.9% of the total respondents report

## *How the Capital Equipment Dollar Will Be Spent (%)*



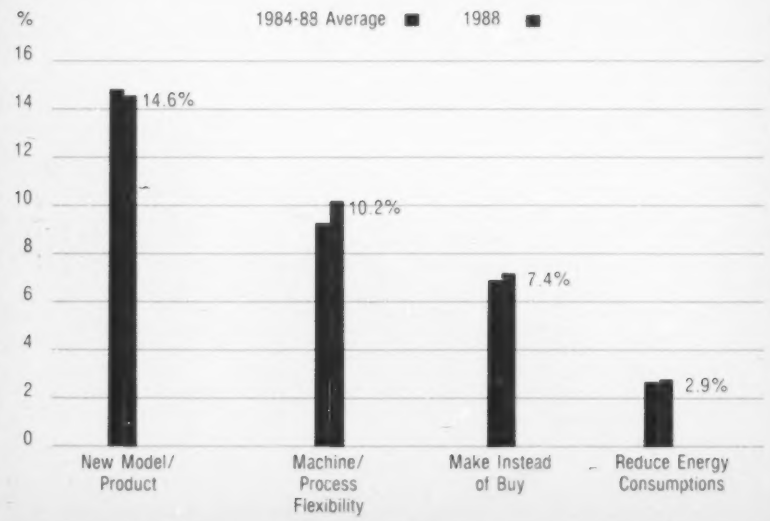

*Note: Tan areas indicate increased investment projection in category over last year. To compare changes in projections between 1988 and last year's survey, see "Comparison of Spending Intentions, 1987 and 1988."*

## *The Reasons Behind Equipment Purchases (Total Respondents 1984-1988)*



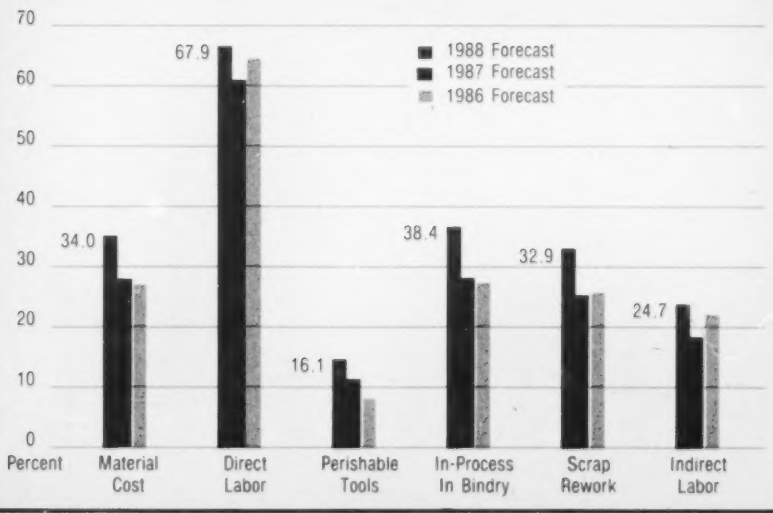

***Cost reduction continues to be the number one reason for machinery and equipment purchases. The jump in increased capacity reflects the need in contracting plants to meet outsourcing requirements. The continued emphasis on the need to improve quality was also expected.***

## *Other Motives for Planned Machinery/ Equipment Investments Total Respondent 1984-88*




***The relative priorities of the "other motives for capital spending" show little change with the following exceptions: machine/process flexibility has increased in importance each year as a motive to purchase new equipment; make instead of buy has trended downward for the past four years until this year when it turned back up reflecting the needs of smaller contract shops to meet the needs of large plant outsourcing.***

## *Primary Cost Targets for Capital Investment* (%)




they currently use EDM machines.

**Lasers.** 11.1% of the total respondents plan to purchase lasers during the next three years. As in past years, laser purchases are originating in medium-sized to large plants—86% of planned buyers are located in plants employing 100 or more persons; 37% in plants employing 500 or more—thus continuing the trend discerned over the last three years. 66.3% of those plants planning laser purchases indicated the types they are interested in. Of these: 46.7% will buy $CO_2$; 31.9%, YAG; and 27.7%, helium-neon. Planned applications by these buyers are: gaging/measurement, 40.9%; cutting, 39.6%; welding, 24.5%; drilling, 11.1%; heat processing, 4.2%.

**Offshore sourcing.** On an overall basis, 31% of total capital expenditures for production equipment will be sourced offshore in 1988. This amounts to $2.72 billion. Better than four of 10 (43%) of the total respondents plan to use offshore suppliers for a portion of their equipment needs. This compares to almost 50% of the respondents to last year's survey. Those planning to order offshore will allocate 43.1% of their total capital budgets up slightly from last year's 42%.

60.3% of these respondents plan to buy metalcutting machines; 16.8% metalforming machines and equipment; 14.8% gaging/inspection/testing equipment; 31.0% other types of equipment including assembly, joining, plastic molding, heat processing and material handling equipment.

Quality continues to rank as the number one reason for offshore sourcing and was ranked by 75.7% of the respondents, followed by price (66.7%), availability (39.2%) and service (23.4%). P

***For a copy of the Capital Spending Survey Results, please write on company letterhead to "Survey Results," PRODUCTION Magazine, 6600 Clough Pike, Cincinnati, OH 45244-4090.***

# Spending Patterns

***For each of the nine production equipment categories listed, the industries cited are those that account for at least 75% of the planned 1988 investments for that particular type of equipment. Industries not listed do not make significant investments in equipment of that type. Comparing your company's investment plans with your industry is simple. Determine the amounts, by percentage, of total capital expenditures budgeted for each of the equipment categories. Then compare those amounts with the listings.***

## *Heat Processing Equipment*

The average respondent company will allocate 1.9% of total investment to heat processing equipment.

| SIC | Industry | % of Total Capital Expenditures |
|---|---|---|
| 342 | Cutlery, handtools, hardware | 2.3 |
| 345 | Screw machine products | 4.5 |
| 346 | Metal forgings and stampings | 3.2 |
| 347 | Coating, engraving and allied services | 3.7 |
| 348 | Ordnance and accessories, except vehicles and guided missiles | 2.2 |
| 352 | Farm and garden machinery and equipment | 2.5 |
| 362 | Electrical industrial apparatus | 2.4 |
| 363 | Household appliances | 3.8 |
| 367 | Electrical components and accessories | 3.0 |
| 371 | Motor vehicles, motor vehicle equipment | 2.4 |
| 372 | Aircraft and parts | 4.1 |
| 375 | Motorcycles, bicycles and parts | 7.5 |
| 376 | Guided missiles, space vehicles and parts | 9.3 |
| 379 | Miscellaneous transportation equipment | 2.5 |
| 384 | Surgical, medical and dental instruments and supplies | 3.4 |

## *Cleaning and Finishing Equipment*

The average respondent company will allocate 6.8% of total investment to cleaning and finishing equipment.

| SIC | Industry | % of Total Capital Expenditures |
|---|---|---|
| 341 | Metal cans and shipping containers | 12.3 |
| 342 | Cutlery, handtools, hardware | 12.3 |
| 343 | Heating equipment, except electric and warm air; and plumbing fixtures | 15.7 |
| 344 | Fabricated structural metal products | 10.0 |
| 347 | Coating, engraving, and allied services | 48.8 |
| 352 | Farm and garden machinery and equipment | 9.1 |
| 353 | Construction, mining and material handling machinery and equipment | 7.5 |
| 358 | Refrigeration and service industry machinery | 9.9 |
| 363 | Household appliances | 9.9 |
| 364 | Electrical lighting and wiring equipment | 9.9 |
| 367 | Electronic components and accessories | 8.0 |
| 371 | Motor vehicles, motor vehicle equipment | 9.0 |
| 372 | Aircraft and parts | 7.6 |
| 374 | Railroad equipment | 8.6 |
| 379 | Miscellaneous transportation equipment | 11.8 |
| 383 | Optical instruments and lenses | 8.6 |

## *Metalforming Machinery/Equipment*

The average respondent company will allocate 15.1% of total investment to metalforming machinery and equipment.

| SIC | Industry | % of Total Capital Expenditures |
|---|---|---|
| 341 | Metal cans and shipping containers | 22.7 |
| 342 | Cutlery, handtools, hardware | 19.7 |
| 344 | Fabricated structural steel products | 26.5 |
| 346 | Metal forgings and stampings | 38.1 |
| 352 | Farm and garden machinery and equipment | 26.5 |
| 353 | Construction, mining and material handling machinery and equipment | 15.1 |
| 358 | Refrigeration and service industry machinery | 29.3 |
| 361 | Electrical transmission and distribution equipment | 23.7 |
| 363 | Household appliances | 20.1 |
| 364 | Electrical lighting and wiring equipment | 16.8 |
| 371 | Motor vehicles, motor vehicle equipment | 13.4 |
| 374 | Railroad equipment | 17.5 |

## *Material Handling Equipment*

The average respondent company will allocate 5.1% of total investment to material handling equipment.

| SIC | Industry | % of Total Capital Expenditures |
|---|---|---|
| 341 | Metal cans and shipping containers | 13.3 |
| 342 | Cutlery, handtools, hardware | 5.2 |
| 343 | Heating equipment, except electric and warm air; and plumbing fixtures | 8.7 |
| 344 | Fabricated structural metal products | 8.5 |
| 352 | Farm and garden machinery and equipment | 6.4 |
| 356 | General industrial machinery and equipment | 6.0 |
| 357 | Office, computing and accounting machines | 11.4 |
| 358 | Refrigeration and service industry machinery | 6.0 |
| 363 | Household appliances | 7.0 |
| 364 | Electrical lighting and wiring equipment | 7.8 |
| 366 | Communications equipment | 16.3 |
| 367 | Electronic components and accessories | 6.8 |
| 369 | Miscellaneous electrical machinery, equipment and supplies | 6.2 |
| 371 | Motor vehicles, motor vehicle equipment | 7.1 |
| 373 | Ship and boat building and repairing | 19.6 |
| 374 | Railroad equipment | 10.0 |
| 376 | Guided missiles and space vehicles and parts | 6.0 |
| 379 | Miscellaneous transportation equipment | 6.3 |
| 383 | Optical instruments and lenses | 9.3 |
| 386 | Photographic equipment and supplies | 6.7 |

## *Assembly Machines/ Equipment*

The average respondent company will allocate 11.7% of total investment to assembly machines/equipment.

| SIC | Industry | % of Total Capital Expenditures |
|---|---|---|
| 342 | Cutlery, handtools, hardware | 14.3 |
| 343 | Heating equipment, except electric and warm air; and plumbing fixtures | 17.4 |
| 348 | Ordnance and accessories, except vehicles and guided missiles | 16.5 |
| 357 | Office, computing and accounting machines | 34.8 |
| 361 | Electrical transmission and distribution equip. | 25.8 |
| 362 | Electrical industrial apparatus | 17.5 |
| 363 | Household appliances | 16.9 |
| 364 | Electrical lighting and wiring equipment | 22.4 |
| 365 | Radio and TV receiving equipment, except communication types | 32.0 |
| 366 | Communications equip. | 30.6 |
| 367 | Electronic components and accessories | 28.1 |
| 369 | Miscellaneous electrical machinery, equipment and supplies | 39.4 |
| 371 | Motor vehicles, motor vehicle equipment | 14.0 |
| 374 | Railroad equipment | 11.8 |
| 379 | Miscellaneous transportation equipment | 20.0 |
| 381 | Engineering, laboratory, scientific and research instruments and equip. | 19.1 |
| 382 | Measuring and controlling instruments | 18.5 |
| 384 | Surgical, medical and dental instruments and supplies | 17.3 |
| 387 | Watches, clocks, clockwork-operated devices, and parts | 50.7 |

## *Metalcutting Machine Tools*

The average respondent company will allocate 35.9% of total investment to metalcutting machine tools.

| SIC | Industry | % of Total Capital Expenditures |
|---|---|---|
| 345 | Screw machine products | 55.8 |
| 348 | Ordnance and accessories, except vehicles and guided missiles | 41.5 |
| 349 | Miscellaneous fabricated metal products | 42.8 |
| 351 | Engines and turbines | 57.0 |
| 353 | Construction, mining and material handling machinery and equipment | 45.2 |
| 354 | Metalworking machinery and equipment | 68.3 |
| 355 | Special industry machinery | 60.3 |
| 356 | General industrial machinery and equipment | 48.1 |
| 359 | Miscellaneous machinery and equipment | 71.0 |
| 362 | Electrical industrial apparatus | 30.0 |
| 371 | Motor vehicles, motor vehicle equipment | 29.9 |
| 372 | Aircraft and parts | 52.1 |
| 375 | Motorcycles, bicycles and parts | 43.3 |
| 381 | Engineering, laboratory, scientific and research instruments and equipment | 37.7 |
| 382 | Measuring and controlling instruments | 33.9 |
| 383 | Optical instruments and lenses | 43.6 |

## *Plastic Molding Equipment*

The average respondent company will allocate 2.5% of total investment to plastic molding equipment.

| SIC | Industry | % of Total Capital Expenditures |
|---|---|---|
| 343 | Heating equipment, except electric and warm air; and plumbing fixtures | 6.0 |
| 347 | Coating, engraving and allied services | 3.1 |
| 349 | Miscellaneous fabricated metal products | 3.3 |
| 352 | Farm and garden machinery and equipment | 2.6 |
| 361 | Electrical transmission and distribution equipment | 4.5 |
| 362 | Electrical industrial apparatus | 5.0 |
| 363 | Household appliances | 15.0 |
| 364 | Electrical lighting and wiring equipment | 5.5 |
| 365 | Radio and TV receiving equipment, except communications types | 4.8 |
| 367 | Electronic components and accessories | 3.2 |
| 369 | Miscellaneous electrical machinery, equipment and supplies | 3.8 |
| 374 | Railroad equipment | 5.5 |
| 381 | Engineering, laboratory, scientific and research instruments and equipment | 3.4 |
| 382 | Measuring and controlling instruments | 6.6 |
| 384 | Surgical, medical and dental instruments and supplies | 9.6 |
| 385 | Ophthalmic goods | 16.7 |
| 386 | Photographic equipment and supplies | 24.4 |
| 387 | Watches, clocks, clockwork-operated devices, and parts | 15.0 |

## *Gaging/Inspection/ Testing Equipment*

The average respondent company will allocate 7.9% of total investment to gaging/inspection/testing equipment.

| SIC | Industry | % of Total Capital Expenditures |
|---|---|---|
| 345 | Screw machine products | 9.7 |
| 346 | Forgings and stampings | 7.3 |
| 348 | Ordnance and accessories, except vehicles and guided missiles | 8.3 |
| 351 | Engines and turbines | 16.0 |
| 354 | Metalworking machinery and equipment | 7.7 |
| 356 | General industrial machinery and equipment | 7.1 |
| 357 | Office, computing and accounting machines | 23.8 |
| 361 | Electrical transmission and distribution equipment | 8.6 |
| 362 | Electrical industrial apparatus | 9.7 |
| 365 | Radio and TV receiving equipment, except communication types | 17.4 |
| 366 | Communications equipment | 17.5 |
| 367 | Electronic components and accessories | 11.6 |
| 369 | Miscellaneous electrical machinery, equipment and supplies | 12.3 |
| 371 | Motor vehicles, motor vehicle equipment | 7.9 |
| 372 | Aircraft and parts | 9.0 |
| 374 | Railroad equipment | 13.4 |
| 375 | Motorcycles, bicycles and parts | 10.0 |
| 376 | Guided missiles and space vehicles and parts | 13.3 |
| 382 | Measuring and controlling instruments | 11.5 |
| 383 | Optical instruments and lenses | 7.9 |
| 387 | Watches, clocks, clockwork-operated devices, and parts | 11.7 |

## *Welding/Riveting/Brazing Equipment*

The average respondent company will allocate 4.1% of total investment to welding/riveting/brazing equipment.

| SIC | Industry | % of Total Capital Expenditures |
|---|---|---|
| 341 | Metal cans and shipping containers | 5.3 |
| 344 | Fabricated structural steel products | 11.7 |
| 349 | Miscellaneous fabricated metal products | 4.6 |
| 351 | Engines and turbines | 4.4 |
| 352 | Farm and garden machinery and equipment | 6.9 |
| 353 | Construction, mining and material handling machinery and equipment | 6.5 |
| 355 | Special industry machinery | 6.3 |
| 356 | General industrial machinery and equipment | 5.8 |
| 358 | Refrigeration and service industry machinery | 5.3 |
| 361 | Electrical transmission and distribution equipment | 6.3 |
| 363 | Household appliances | 7.1 |
| 364 | Electrical lighting and wiring equipment | 5.3 |
| 371 | Motor vehicles, motor vehicle equipment | 6.4 |
| 373 | Ship and boat building and repairing | 16.1 |
| 374 | Railroad equipment | 10.5 |
| 379 | Miscellaneous transportation equipment | 18.8 |
| 383 | Optical instruments and lenses | 12.9 |

# Whither Technology?

***A new report from the Industrial Technology Institute should give pause to anyone concerned with the reindustrialization of America. Technology isn't catching on like some think that it has.***

*By Gary S. Vasilash*
*Senior Editor*

THE INTELLIGENT GOOD LOOKS AND quiet demeanor of Edith Wiarda belie the fact that she has what is either extremely good news or bad news for American manufacturers. The enormity of the information seems to require that she be somehow outsized. And as for the spin that one puts on the data: it's like whether the proverbial glass of water is half full or empty.

When we met in the headquarters of the Industrial Technology Institute (ITI), where Wiarda is a researcher in the Industry Affairs and Policy Group, Center for Social and Economic Issues, the building, which could be appropriate for a set on *Star Trek: The Next Generation* (see *Architectural Record,* July 1987, if you're skeptical), was finally having its official dedication.

Michigan governor James Blanchard was bursting with pride, having been in Ann Arbor just a few weeks earlier to announce the fact that the National Center for Manufacturing Sciences had selected the state for its headquarters. Here he was, just a few miles north at ITI, with another major high-tech manufacturing center to talk about. He tells the assembled well wishers that being competitive isn't enough: he's interested in *winning.* Also on the dais is GM chairman and strong ITI supporter Roger B. Smith. He states that "this is a very important day for the U.S. auto industry." With the industry facing its greatest competitive challenge, one that's growing, the combination of advanced technology and skilled workers that ITI is working to develop and promote would be, Smith says, a major positive force.

Which is all true.

However, a few minutes with Wiarda changes opinions about the so-called competitive edge, to say nothing about winning.

**Looking at manufacturing.** Wiarda was the principal investigator on a study called *Frostbelt Automation: The ITI Status Report on Great Lakes Manufacturing.* The study, performed under a grant from the W.K. Kellogg Foundation, is based on the results of 1,344 telephone interviews conducted between June and September 1986. There were 188 specific questions—yes/no, multiple choice, and short answer—asked of personnel at plants employing 10 or more persons and where manufacturing is the primary function. With regard to establishment size, 523 were of 10 to 49 employees, 494 had 50 to 249 employees, and 327 had 250 or more employees.

Those questioned are all within the U.S. Department of Commerce's definition for durable goods manufacturing, which includes these Standard Industrial Classification (SIC) groups: 24, Lumber and Wood Products; 25, Furniture and Fixtures; 32, Stone, Clay and Glass Products; 33, Primary Metal Industries; 34, Fabricated Metal Products; 35, Non-Electrical Machinery; 36, Electrical and Electronic Machinery; 37, Transportation Equipment; 38, Measuring, Analyzing, and Controlling Instruments; and 39, Miscellaneous Manufacturing Industries. (Note: PRODUCTION's readership closely parallels that list).

The "frostbelt," or Great Lakes region, was considered as Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin. These states, in 1982, accounted for 27.8 percent of the nation's durable goods output.

**Technology patterns.** The survey was interested in the use of 13 technologies—10 "hard" or equipment-based, and three "soft" or software

and people-based. The former are: automated in-process inspection, robots, automated material handling systems, computer-aided design, computer-aided engineering packages, numerically controlled machine tools, computer numerically controlled machine tools, programmable controllers, local area networks, and shop floor microcomputers or personal computers. The "soft" technologies are production planning and inventory control software, statistical process control, and group technology.

The result of this work is what Wiarda calls a "snapshot": an indication of the state of affairs at a particular point in time. The data and some interpretations are collected into two volumes, one dedicated to technology patterns and applications, and the other detailing what is occurring in each of the states. The set of books represents a most valuable working tool for anyone involved in durable goods manufacturing, whether from the standpoint of thinking about where to locate a facility (the amount of skill levels in an area can undoubtedly be determined based on the amount of technology in a state), outsourcing (the amount of technology gives an indication of prime areas to consider), marketing (who needs what and where)...the possibilities are almost endless. There's no other data base like it.

This is but a brief look at some of the information included in the ITI study.

**Why so rare?** The overall numbers are the most startling. For example, of the 13 technologies, an average of just 2.3 are used by the establishments. The most widely adopted, production planning and inventory control software, was found at 59.4 percent of the facilities. Number two, with 25.9 percent, was SPC. The implementation rate of NC and CNC combined is 24.2 percent. Then the numbers fall into the teens for programmable controllers (17.7 percent), CAD (17.5 percent) group technology (16.4 percent) shop floor PCs (16.1 percent), and local area networks (13.1 percent).

The remaining technologies are very low, with robots at 6.8 percent, computer-aided engineering at 6.6 percent, and automated inspection and automated material handling tied for the basement at 6.5 percent.

### *Great Lakes Durable Goods Manufacturers Adoption of 13 Advanced Technologies*

| Technology | Adoption Rate % |
|---|---|
| Production Planning and Inventory Control Software | 59.4 |
| SPC | 25.9 |
| CNC* | 19.0 |
| Programmable Controllers | 17.7 |
| CAD | 17.5 |
| Group Technology | 16.4 |
| Shop Floor PCs | 16.1 |
| Local Area Networks | 13.1 |
| NC* | 11.9 |
| Robots | 6.8 |
| CAE | 6.6 |
| Automated Inspection | 6.5 |
| Automated Material Handling | 6.5 |

*For NC/CNC combined: implementation rate = 24.2%

Source: *Frostbelt Automation*, Industrial Technology Institute, 1987.

Asked about what she makes of this skew, Wiarda replies, "If you think about the hard technologies—equipment—versus the soft—managerial—it's clear that people tend to be more involved in production planning and inventory control software of some sort, which means anything from running something on a PC to a full-blown MRP system.

"SPC is another of the most commonly cited. I'm of two minds about that. One reason might be that people are starting to recognize that before getting into expensive hardware systems, it makes sense to think about how their organization is managed and to organize the production system." Wiarda adds, "It may be a very hopeful sign that people are doing the managerial work as a precursor—or it could be a reflection of going for lower-cost options and an inability or an unwillingness to spend."

**Shallow but potential.** In addition to measuring the breadth of technology use in the industries, a yardstick measuring the intensity, or depth, of usage was also established. So while Transportation Equipment scored second in breadth with an average 2.7 technologies employed (only Instruments, SIC 38, was higher with 3.0), its depth was only 11.2 on a scale of zero to 100. It seems as if automotive uses lots of different technologies on an almost experimental basis, which could bode well for its future capabilities.

**Big plants boom.** With regard to overall technology adoption, the ITI data show that the action is in the plants with 50 to 249 employees and 250 employees and above. The average number of technologies adopted by the former is 3.1 out of 13, while the big plants utilize an average of 5.6 technologies. Of the 13 technologies, big plant adoption leads in all categories, from a high of 86 percent with production planning and inventory control software to 26 percent with automated material handling.

Correlating the big plants and SICs, the Transportation Equipment (SIC 37) 250+ plants lead the way with 6.7 technologies adopted. It's followed by both Non-Electrical Machinery (SIC 35) and Instruments (SIC 38), both of which have adopted 6.2 technologies.

While the figure for overall use of automated inspection—an average 6.5 percent of plants claimed to have it—may be somewhat disconcerting, there is a brighter picture when specific SICs of big plants are examined. For example, in the 250+ plants of SICs 32, 36, 37, and 38 (Stone, Clay and Glass Products; Electrical and Electronic Machinery; Transportation Equipment; and Measuring, Analyzing and Controlling Instruments), the percentages of adoption are 32.4, 35.0, 40.7, and 40.0, respectively. The average for the big plants in all of the durable goods categories covered is 29.7 percent.

Similarly, automated material handling fares well in big plants, with Transportation leading the way with 49.8 percent, followed by Primary Metals (SIC 33) with 35.8 percent and Lumber and Wood Products (SIC 24) with 30.8 percent.

In another field, for example, the report states, "Establishments with more than 250 employees were more than three times as likely to have adopted NC or CNC as those with fewer than 50 employees." (Speaking of technology use in general in the 10 to 49 employee category, Wiarda says, "There's almost a pattern of all or nothing for the smaller guys." She adds, however, "Those who are in it are in it very heavily.")

One simple explanation for the predominance of activity in the big plants can be borrowed from Willie Sutton: "It's where the money is."

In spite of the relative high numbers in the 250+ plants, it is very clear from the report that there are plenty of plants out there in need of technology if they are going to be competitive (and winners), and if some of them are going to serve the domestic auto industry with the quality and price that it requires. This quasi-dearth of technology may be interpreted as a reason to feel poorly about American manufacturing in general (extrapolating from the Great Lakes to the rest of the country) or it can be seen as a tremendous opportunity: Imagine how productive durable goods manufacturing will be once the benefits of manufacturing are realized!

**Looking ahead.** There's a slight snag on the latter view. Although the survey is, essentially, temporally static (i.e., a point in time), respondents were asked about their plans to buy additional technology within two years. Result: 60.6 percent said no.

However, the good news is that the 250+ plants are bullish. Over all the SICs, 55.4 percent say they plan to get new technologies within two years, with Instruments (SIC 38) leading the way, with 75.4 percent saying yes, and Lumber and Wood Products following close behind at 73.1 percent. The lowest number comes from Fabricated Metal Products (SIC 34), which has 45.4 percent looking at new technologies.

Although statistics are often said to be dubious (as in "Lies, damn lies, and statistics"), one thing is for certain: there is plenty of room for improvement in durable goods manufacturing. P

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